BIOLOGICAL EVALUATION OF GYPSY MOTH

At

CATOCTIN MOUNTAIN PARK

2008

Prepared by

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ABSTRACT

On September 8-10, 2008, USDA Forest Service personnel conducted a gypsy moth egg mass survey at Catoctin Mountain Park (CATO). The purposes of the survey were to determine gypsy moth population densities, evaluate the efficacy of this year's treatments, assess the potential for defoliation and the need for treatment in 2009. Current populations are sufficient to cause light defoliation on 833 acres. Treatment is recommended to prevent defoliation possible branch dieback, and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all the new (2008) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. Egg mass lengths were measured at the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity.

RESULTS

The location of the survey plots along with the 2008 treatment areas are shown in Figure 1. The summarized results of the survey are presented in Table 1. In brief, egg mass densities ranged from 0-4040 and averaged 227 egg masses per acre. Overall egg mass lengths tended to be moderate to large in size, ranging from 20-48 mm and averaging 31 mm.

Egg mass densities in the single application *Bacillus thuringienis* variety ***kurstaki (Btk)*** blocks have been reduced 74 percent from the pre-treatment level (2007) of 859 to the current level of 223 egg masses per acre. Egg mass densities in the double application Btk blocks have been reduced 98 percent from the pre-treatment level of 3191 to the current level of 66 egg masses per acre.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (30-50 percent); and heavy (51-100 percent). Defoliation less than 30 percent generally has little impact on trees and can not be detected through aerial surveys.

The survey results indicate that light defoliation is likely on 833 acres (Figure 2). This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would

increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and prediction defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 980 egg masses per acre (average egg mass density in block 1) x 38 mm (average egg mass length in block 1) translates to a projected defoliation level of about 39 percent (light defoliation). Because egg mass densities and the host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately light throughout this area of CATO. Light defoliation is also predicted for blocks 2-9.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be fairly healthy throughout most areas surveyed at CATO. While the average egg mass length is 31 mm, it is a decrease from last year's average of 35 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at CATO in 2008. Although it is still possible that either the gypsy moth fungus or the NPV could cause the general collapse of the gypsy moth population next year, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2009.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light defoliation (<50 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. CATO experienced a prolonged and severe drought during the 2007 growing season, and again late in the 2008 growing season. Approximately 12.4 acres of light defoliation were detected at CATO in 2007 and 15.1 acres were detected in 2008. Less than 1 acre of the defoliation was detected within the 2008 treatment areas.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak saw timber and 14 percent of the total oak pole timber occurred after one year of light to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at CATO and the factors mentioned above, scattered areas of tree mortality are expected if defoliation occurs. Mortality will be more severe if adequate rainfall is not received during the 2009 growing season and or defoliation occurs on trees that were previously defoliated.

Management Options

In 2009, two management options have been evaluated for managing gypsy moth populations at CATO. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure, branch dieback and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations, viral epizooics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Although it is not possible to accurately assess such events with the defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations information at hand, it is unlikely that a collapse will occur in 2009 since most of these areas are either newly infested and/or there is an abundance of fairly healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al., (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that scattered areas of defoliation will occur at CATO in 2009 (Figure 2).

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk)*. This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al., (1996) in West Virginia. Miller's study involved a large scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1 year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½ -1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when

gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 4×10^{11} occlusion bodies (OB's) per acre applied in a single application or 2×10^{11} OB's per acre applied in a double application. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2009 should this insecticide be preferred for use at CATO.

Alternatives

With the previously described options in mind, the following alternatives are offered:

Alternative 1. - No action.

Alternative 2. - One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3. - Two aerial applications of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4. - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of ¾ gallon per acre.

Alternative 5. - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of ¾ gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations at CATO are sufficient to cause 833 acres of defoliation in 2009. To protect tree foliage, prevent branch dieback and prevent tree mortality, our recommendation is alternative 4 (a single application of Gypchek).

This recommendation is based on the following considerations:

1) This expected defoliation interferes with the management objectives of CATO.

2) The National Park Service would like to use the most host specific insecticide available.

3) Based on the current population levels, a single application of Gypchek is likely to provide both foliage protection and a population reduction.

4) A single application of Gypchek is more economical than a double application of Gypchek.

REFERENCES

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Table 1. – Results of the gypsy moth egg mass survey conducted at Catoctin Mountain Park on September 8-10, 2008.

Plot #	#em/acre	Em size (mm)	Plot #	em/acre	em size (mm)
1	280	--	38**	0	--
2[z]	1000	28	39*	120	--
3	160	45	40**	40	--
4*	160	--	41**	0	--
5*[z]	960	48	42**[z]	600	23
6*	40	--	43**	0	--
7*	80	36	44[z]	1000	27
8[z]	1760	28	45*[z]	480	31
9[z]	4040	31	46**	0	--
10[z]	40	--	47**	0	--
11[z]	640	30	48**[z]	360	37
12[z]	600	--	49**	0	--
13	120	--	50**	40	--
14	80	--	51**	0	--
15[z]	480	--	52**	160	--
16[z]	1240	25	53**	160	31
17[z]	960	35	54**	0	--
18[z]	680	--	55**	0	--
19	200	--	56**	0	--
20	240	--	57**	0	--
21*	160	--	58**	0	--
22*	80	--	59**	0	--
23*	0	--	60**	0	--
24[z]	560	24	61**	120	--
25*[z]	920	22	62**	0	--
26*	80	20	63**	0	--
27*	80	38	64**	0	--
28*	40	--	65**	0	--
29*[z]	280	27	66**	0	--
30*	120	--	67**	0	--
31*[z]	760	23	68**	0	--
32*	40	42	69**	0	--
33*	40	--	70**	0	--
34*	0	--	71**	80	--
35**	0	--	72**	40	--
36**	40	--	73**	0	--
37**	480	31	74**	0	--

Table 1 (continued). – Results of the gypsy moth egg mass survey conducted at Catoctin Mountain Park on September 8-10, 2008.

Plot #	#em/acre	Em size (mm)
75**	0	--
76**^{z}	360	28
77**^{z}	560	28
78**^{z}	560	30
79**	0	--
80**	0	--
81**	0	--
82**	0	--
83**	0	--
84**	0	--
85**	0	--
86**	0	--
87**	40	--
88**	80	--
89--	200	--

Plot #	em/acre	em size (mm)
90**	200	--
91**	0	--
92**	0	--
93**	0	--
94**	0	--
95**	0	--
96**	0	--
97**	0	--
98**^{z}	280	45
99**^{z}	440	--
100**	0	--
101**	0	--
102**	0	--
103**	0	--

egg mass/acre range = 0 – 4040
egg mass/acre average = 227

egg mass size range (mm) = 20-48
egg mass size average (mm) = 31

* = plot located in single application Btk blocks
egg mass/acre range in single application Btk blocks = 0-960
egg mass/acre average in single application Btk blocks = 223

egg mass size range (mm) in single application blocks = 20-48
egg mass size average (mm) in single application Btk blocks = 32

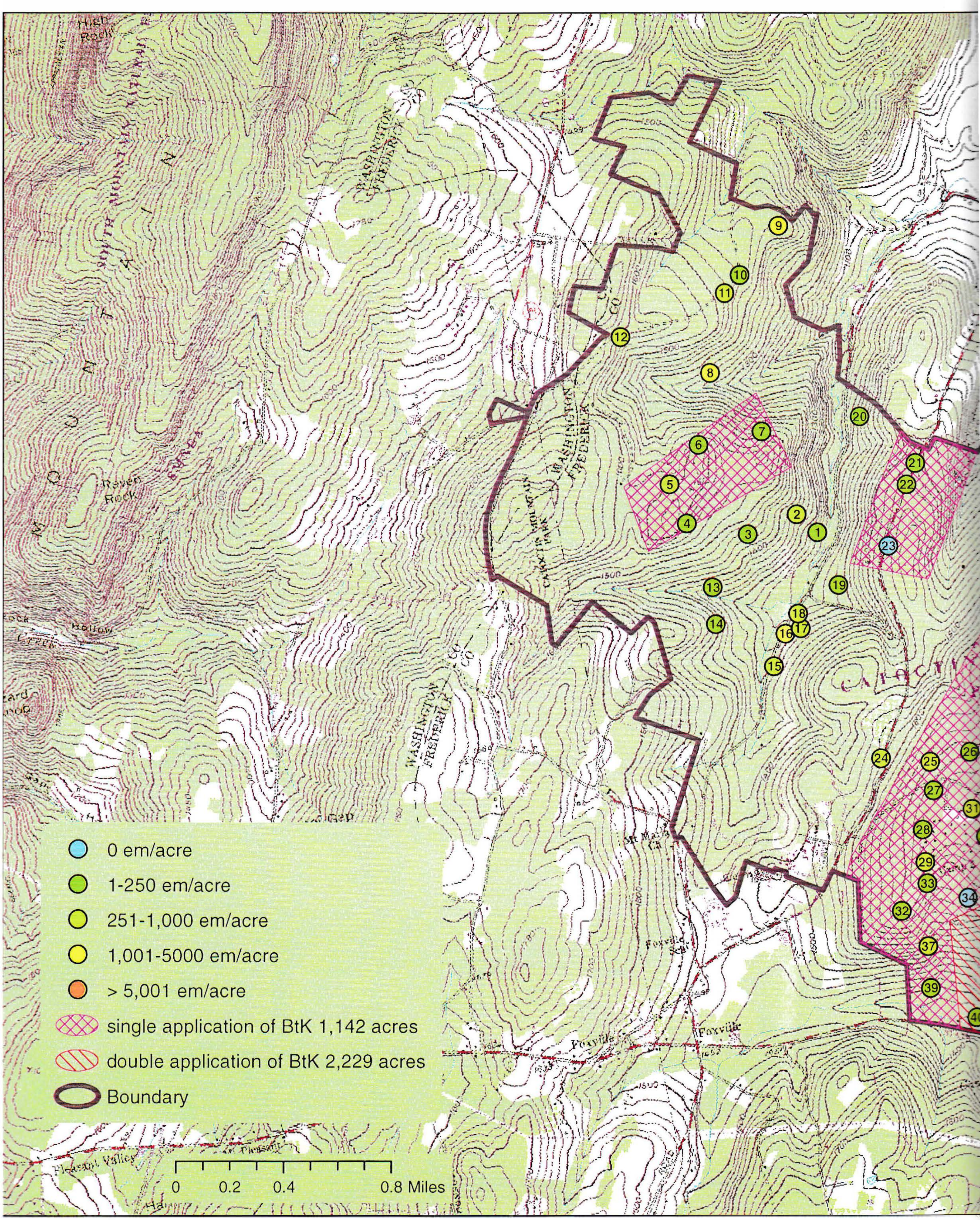
* = plot located in double application Btk blocks
egg mass/acre range in double application Btk blocks = 0-600
egg mass/acre average in double application Btk blocks = 66

egg mass size range (mm) in double application blocks = 23-45
egg mass size average (mm) in double application Btk blocks = 32

^{z} = plot located in 2009 recommended treatment blocks
egg mass/acre range in recommended treatment blocks = 40-4040
egg mass/acre average in recommended treatment blocks = 815

egg mass size range (mm) in recommended treatment blocks =22-48
egg mass size average (mm) in recommended treatment blocks = 30

Figure 1. -- Location of the gypsy moth egg mass survey plots established on September 8-10, 2008, along wit



h the 2008 gypsy moth treatment blocks.

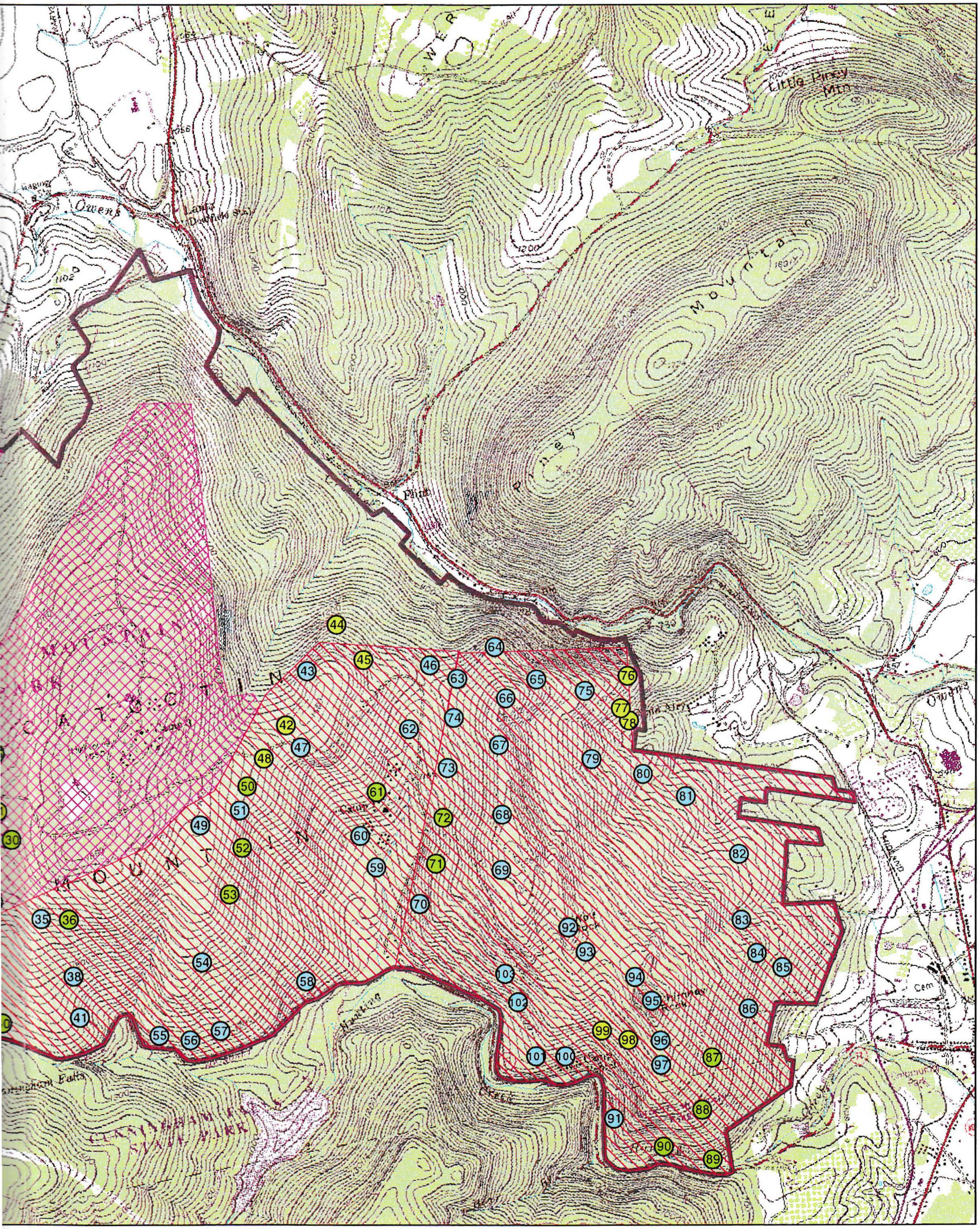
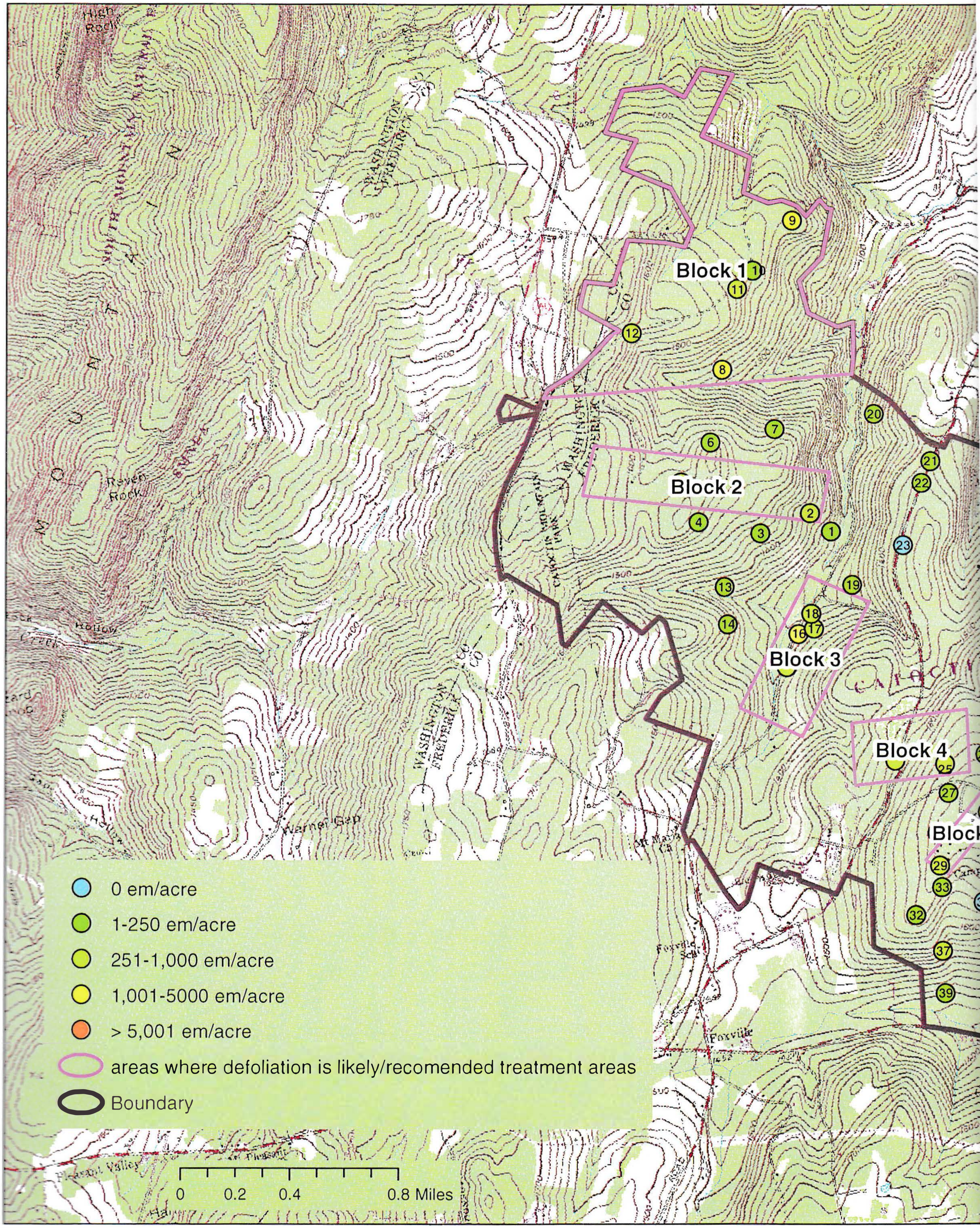
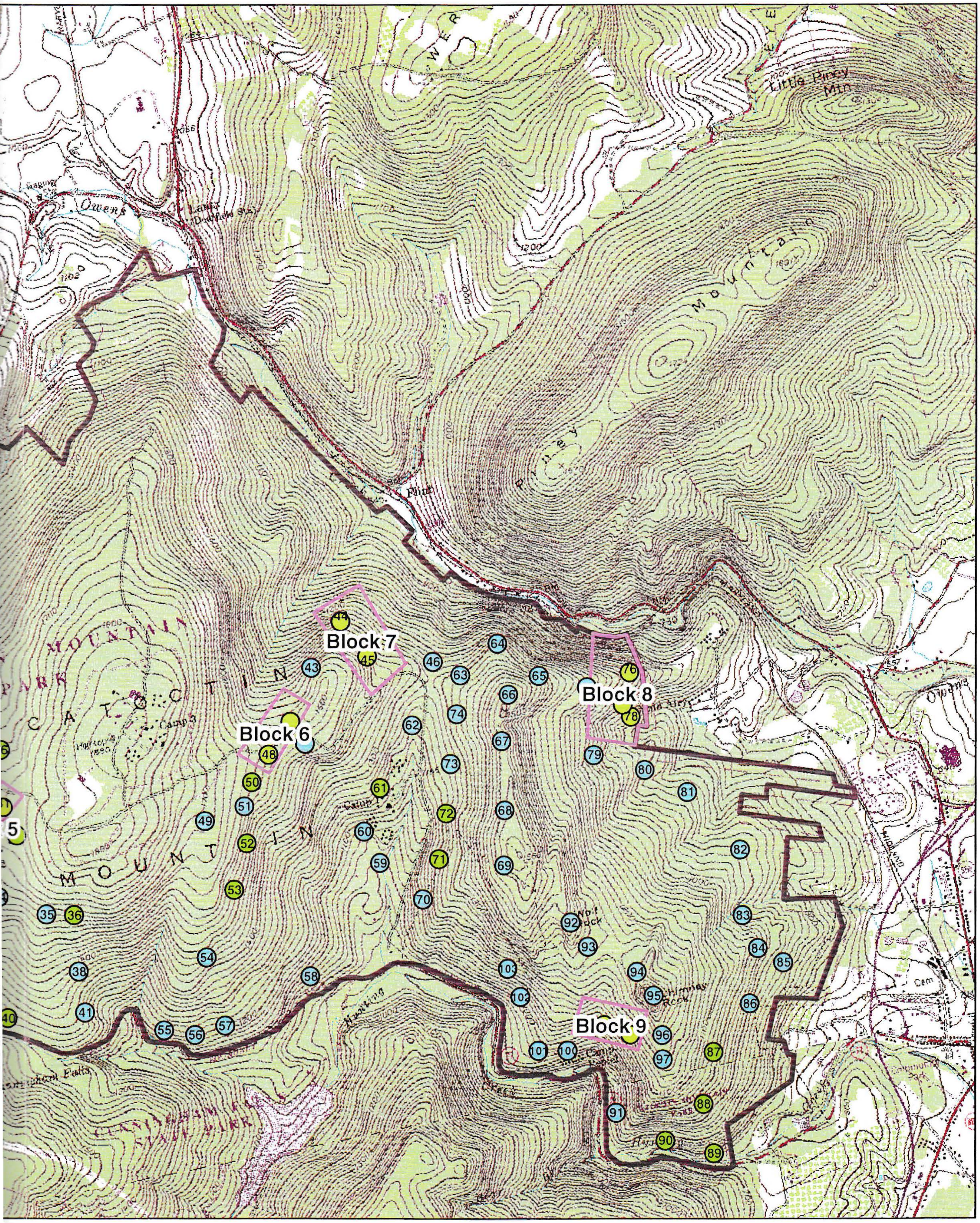


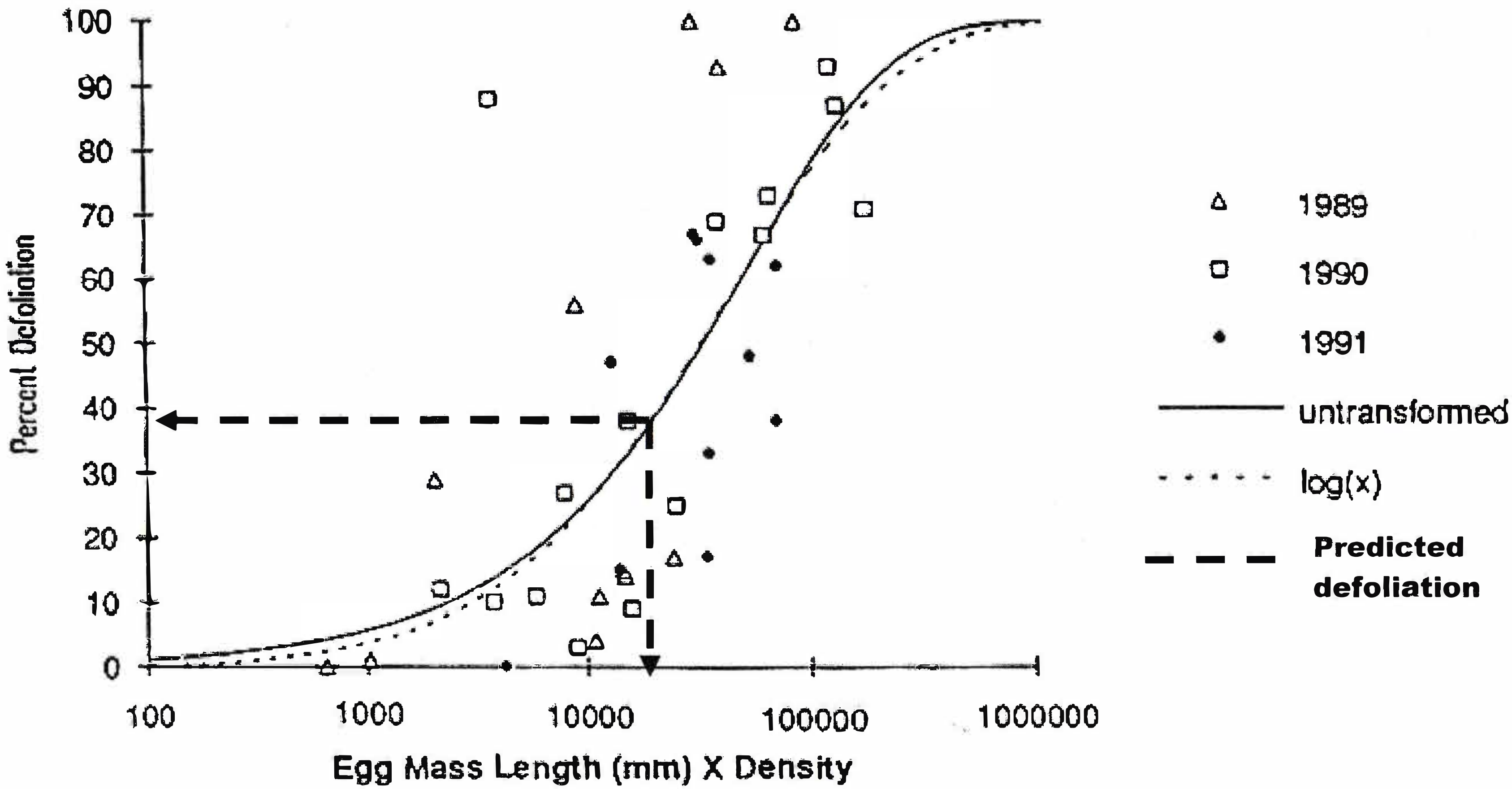
Figure 2. -- Areas where defoliation is likely/recommended treatment areas.





Little Piney Mtn
Piney Mountain
Owens
CATOCTIN MOUNTAIN PARK
Camp 3
Block 6
Block 7
Block 8
Block 9
Wolf Rock
Chimney Rock
Hunting Creek

Figure 3.—Predicted defoliation in block 1 at Catoctin Mountain Park in 2009.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

USDA United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3410
Date: October 14, 2008

Mr. Mel Poole
USDI National Park Service
Catoctin Mountain Park
Thurmont, MD 21788

Dear Mel:

Enclosed is the gypsy moth biological evaluation for Catoctin Mountain Park.

In brief, gypsy moth populations are sufficient to cause light defoliation on 833 acres. We are recommending a single application of Gypchek on the 833 acres. With good timing and proper application, gypsy moth defoliation should be minimal at Catoctin Mountain Park in 2009.

I would like to thank your staff for conducting the preliminary egg mass survey.

Please contact me at 304-285-1555 if you have any questions regarding the gypsy moth biological evaluation.

Sincerely,

Rodney L. Whiteman

RODNEY L. WHITEMAN
Forester
Forest Health Protection

Enclosure

Cc: Sean Denniston, CATO
Steve Tilley, MDA
Thomas Lupp, MDA
Jil Swearingen, CUE
Robert Lueckel, MFO

RLW/blm